PROCESSING/ECONOMIC STRATEGY FOR UPGRADING SHALE OIL

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INTRODUCTION

Green River Shale Oil (Western U. S.) is comprised of polar compounds, principally nitrogen and oxygen types, and non-polar compounds, principally paraffins, olefins and aromatics. The former may be a valuable source of specialty and fine chemicals while the latter may be refined into fuels and other petroleum products. To take full advantage of the values of the polar types, efficient processes for extraction, conversion and utilization of these types must be developed.

COMPOUND TYPES IN SHALE OIL

The compound types found in shale oil include homologs, analogs and benzologs of pyridines, pyrroles, phenols, amides, ketones, nitriles, carboxylic acids, thiophenes and aromatic hydrocarbons. Some of these types are of extremely high value in their pure form. JWBA estimates that up to 10% of a shale oil barrel may be manufacturable into products of value greater than $1,000/bbl.

ECONOMIC STRATEGY

Figure-1 shows the economic strategy for a value-enhancement venture from shale oil. Because recovery of shale oil has been a long-time historical focus, the technology and economics of retorting are fairly well understood (1). A guaranteed purchase of raw shale oil at $30/bbl (non-hytrotreated) is expected to be sufficient to attract a qualified producer into production.

The intermediate stage of value-enhancement targets both broad-range concentrates and feedstocks for finishing by existing manufacturers of specialty and fine chemicals. In both cases, shale oil becomes a substitute source of feedstock. For broad-range concentrates, shale oil may substitute for coal tars; for specialty chemicals, shale oil intermediates may compete economically with synthetically produced intermediates.

PROCESS STRATEGY

Figure-2 shows a process strategy and a possible suite of products obtainable from shale oil. Shale oil is first separated by a thermodynamically logical sequence by molecular weight and polarity. The non-polar compounds are sent to a conventional petroleum refinery for manufacture of fuels, lube oils and waxes. Heavy ends may be used for asphalt or asphalt blending stock. The use of shale oil for specialty asphalt additives has been previously reported (2).

The polar fractions may be further separated to produce concentrates of specific types. Liquid-liquid extraction may employ acid, base, polar or polar-aromatics solvents. Also, liquid-solid adsorption may be used to isolate specific types.

For large molecules, some form of dealkylation is needed to reduce the molecules to their bare-ring or mildly-methylated form. Hydrodealkylation is one such process which has shown promise. The resulting products are finished into concentrates of specific types that are further processed for production of specialty and fine chemicals.

VENTURE STRATEGY

Before unconventional feedstocks can be incorporated into the marketplace as substitutes for conventional feedstocks or as a source of new products, technology must be developed to exploit potential values found in these materials. There has been relatively little attention paid to utilizing shale oil as a source of nitrogen and oxygen-based molecular types and the prospects for breakthrough discoveries is high.

It is likely that unconventional resources such as shale oil, advanced process coal liquids, tar sand bitumen and biomass will become the source of products with new activities (biological, toxicological, etc.) and properties (materials, polymers, etc.).

Ultimately, an opportunity for profitable investment must be developed. This involves not only price/cost relationships, but also market trends and acceptance of products. Current results show favorable price/cost relationships and markets for potential shale oil products are growing (3, 4). The main task is to actually produce products for inspection and introduction to the buyer. Recent results aimed at achieving these objectives will be reported.

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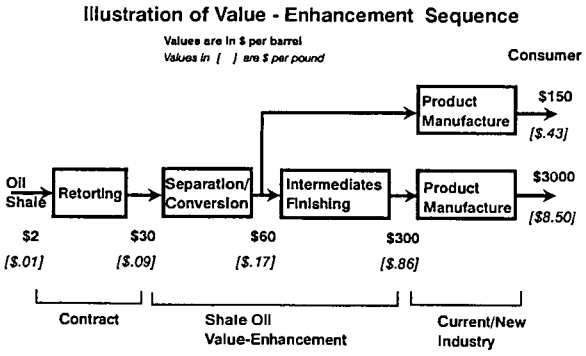

Figure 1.

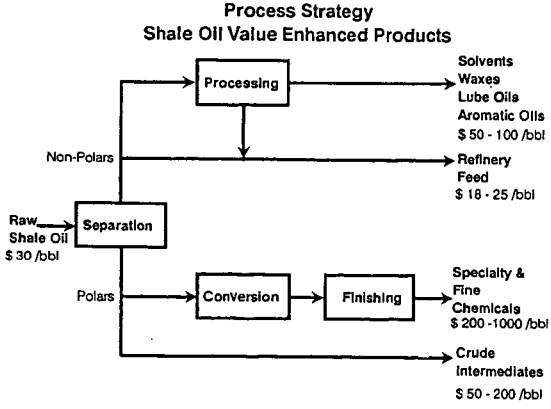

Figure 2.